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ABSTRACT

This paper presents findings of an exploratory study undertaken at Marist Sisters' College in Woolwich, Sydney (Australia) to examine student use of multimedia software packages. Students (n=70) in years 7-12 were randomly selected to complete an evaluation of a popular multimedia package, "Encarta," on the following factors: ease of use, navigation, cognitive load, mapping, screen design, knowledge space complexity, information presentation, media integration, and overall functionality. Findings included: (1) 46% of students commented on the limited quantity of information; (2) 12% of students expressed difficulty managing the search process; (3) 65% of students felt that the electronic information search was easier and more efficient than a traditional print search; and (4) 11% indicated that the task was more fun, interesting and exciting than when using print sources. The major disadvantage of using electronic over print resources was identified as the lack of depth and complexity of information in the search package. Another major disadvantage, not related to the Encarta program, was computer system downtime. The study discusses the implications of these findings for essential effective information literacy instruction in electronic information environments, as well as curriculum directions for schools. (Contains 11 references.) (SWC)

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See No Evil, Hear No Evil, Interact No Evil?

by
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This paper presents the findings of an exploratory study undertaken at Marist Sisters' College in Woolwich, Sydney to examine student use of multimedia packages. The study provides a student-centered evaluation of a popular multimedia package "Encarta", identifies problems with the use of this package, and discusses the implications of these findings for effective information literacy instruction in electronic information environments, as well as curriculum directions for schools.

Theoretical Framework

Multimedia, defined generally as the use of several media such as text, graphics, animation, audio and video integrated in a program that is delivered on a stand-alone computer workstation or via a computer network, is regarded as one of the most important factors shaping schooling for the 21st century. As an information resource, it is full of gloss with its vivid graphics and images, creative screen dissolves, state-of-the-art animations, millions of colors and limitless variety of sights and sounds. It's novel, it's difference and it has a certain magnetic appeal. You can confirm this by walking off the street into any "Timezone" games parlors. In a short period of time it has captured the attention of school students across the globe. (Insert stats. On growth of CD Roms). Current predictions of growth rates in the development of multimedia packages suggest that publishing of multimedia will overtake the publication of books by the turn of the century, and that such sources will be an important aspect of collection development for school libraries.

There is potential for multimedia to make a huge impact on curriculum design, teaching processes, learning strategies and tasks, information seeking and the structure of the learning environment itself. However, the key question remains: will multimedia fulfill its promise? Critical analysis and evaluation of multimedia lags well behind the development of new packages. Much of the evaluative literature on multimedia tends to focus on media and technical aspects. While these might be important qualities, this study recognizes the immediate need of the profession to elucidate and test evaluative criteria that focus on pedagogic dimensions and student usability. Multimedia can be aptly described as continuously work-in-progress. This can only be effectively done through careful formative and summative evaluation processes.

As both teachers and information professionals, teacher- librarians need to understand how multimedia impacts on learning. This is made more critical given the hype that accompanies many multimedia packages. Take a moment to read any of the unevidenced claims embedded in the publishers' blurbs that are being used to entice educators to purchase such products. In one recent catalogue, we found the following claims:

"strengthens their deductive reasoning skills"
"increased productivity"
"develops critical thinking skills, active reading and a high level of comprehension"
"motivates independent reading"
"encourages students to use cooperative strategies"
"turns your students into real research writers"
"teaches students to work together"

To date, there is very little data to substantiate any of these claims.

Underpinning this study is the premise that decisions informed by thoughtful evaluation are better than those based on just guesswork, ignorance, publishers' propaganda or superficial perusal. Evaluations of technology-based packages in the past have tended to adopt simplistic approaches to evaluation, focusing primarily on achievement of goals. However, recent literature

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reflects a greater concern with merit, worth, or value, user perceptions and key concerns and issues. Kazlauskas (1994) for instance identifies a number of learner characteristics that should be considered when designing instruction. These include: cognitive characteristics such as aptitude, developmental level, language development, reading level, visual literacy, cognitive processing style, prior knowledge, learning strategies and general world knowledge; physiological characteristics such as age, sensory perception and health (fatigue); and psychological characteristics such as interests and attitudes, motivation, experience with media, anxiety, locus of control, peer relationship, socio-economic background, and affiliation aspects. These are characteristics of learners that define the utility of any instructional product, including multimedia. Inherent in this idea is the promise that understanding user characteristics and user learning needs should form the framework for making judgements about any instructional package in any medium.

From a similar perspective, Reeves (1992) and Reeves and Harmon (1993) have identified a range of user-centered dimensions that could form the focus of evaluation of multimedia packages. They are in two broad areas: user-orientated dimensions, and pedagogic dimensions (Todd, 1995).

User-Oriented Dimensions

1. **Ease of Use**. This refers to how easily the learner interacts with the multimedia package, and is an aggregate of many of the dimensions that follow.
2. **Navigation**. This refers to the perceived ability to move through the contents in a deliberate, purposeful manner.
3. **Cognitive Load**. What is the mental effort of learning with multimedia? It is important that the structure of the package is clear to learners so that they can efficiently manage simultaneously all the choices and tasks demanded of multimedia, and not be confused by numerous options that increase cognitive load.
4. **Mapping**. This refers to program's ability to track and represent the learner's path through the program, to avoid the problem of user disorientation.
5. **Screen Design**. Does screen design violate principles of screen design or follow the principles? In particular, there should be careful thought given to the appropriateness of design metaphors.
6. **Knowledge Space Complexity**. This focuses on the network of concepts and relationships that compose the mental schema a learner possesses about a topic. It raises the question of expert knowledge versus novice knowledge. It is important that the domain knowledge is structured in a way that learners can create an appropriate semantic organization relevant to their learning tasks and can make inferences about their state of knowledge in relation to an "expert" model of knowledge to be learned.
7. **Information Presentation**. This refers to whether the information contained is presented in an understandable form. The most elegantly designed interface is useless if the information is incomprehensible to the learner. It is important that they can comprehend, analyze, synthesize this information in ways appropriate to their learning tasks, and so that links can be made to existing knowledge.
8. **Media Integration**. How much is it truly a multimedia program and how well does it combine the different media to produce an effective whole? Do they work together to form a coherent program or is it a hodge podge of gratuitous media segments?
9. **Aesthetics**. Is there an overall artistry in the production and design? Does the product possess a beauty or elegance that goes beyond novelty effect? Are the different media used for a good reason?
10. **Overall Functionality**. This relates to perceived utility of the program. While multimedia packages can have multipleuses, does its overall functionality meet its stated objective; does it meet the specific intended use that currently exists in the mind of the learner? Does it enrich the curriculum are for which it is intended?

Pedagogic Dimensions

Teachers tend to make the intuitive assumption that each media type makes a unique contribution to learning. There is the additive assumption that instruction presented in two

mediums produce more learning that instruction in one medium, and the multiplicative assumption that instruction integrating a range of mediums such as using multimedia packages produce even more learning (Clark and Craig, 1992). Within a strong educational framework, the challenge of multimedia lies in using applications that actively engage the learner. Interfaces that are proactive rather than merely an exercise in page turning, pressing buttons to present yet another stream of information, reject role-learning and empower learning "by doing" and reflection. It is this notion of empowerment that underpins the idea of interactively. Other dimensions identified by Reeves (1992) include:

1. **Epistemology**. This relates to theory of knowledge held by designers. Is the package objectivist, that is, concerned with accurate information and where learning is seen as acquiring truth. Or does the package advocate a constructivist, epistemology, reflecting many viewpoints regarding a topic and providing a full range of options from which learners can construct their own knowledge.
2. **Pedagogical Philosophy**. Does it merely transmit information, such that the learner is, at best a button pusher, or does it provide an active learning environment that addresses unique interest, styles, motivators, capabilities of individual learners?
3. **Underlying Psychology**. Does the package function primarily to shape behaviors through stimulus, response, feedback and reinforcement, or does it provide a wide variety of learning strategies that foster the construction of meaning and understanding through opportunities for analysis and synthesis of information? This relates to the notion of interactively.
4. **Goal Orientation**. Does the package enable students to set sharply focused goals?
5. **Instructional Sequencing**. Are the problem solving activities purposefully designed to be intrinsically interesting and challenging, enabling learners to build coherent and logical ideas in new meaningful and relevant contexts?
6. **Experiential Validity**. To what extent does the package provide opportunities for learning situated in real world experience?
7. **Role of Instructor**. Is the package "teacher-proof" - is it merely an authoritarian provider of knowledge, or is it designed to enable teachers to have critical roles as students interact with the package?
8. **Value of Errors**. Does the package provide opportunities for learning from mistakes, or are the potential responses arranged in such a way that learners can only make correct responses?
9. **Motivation**. Is the learning context intrinsically motivating, that is, motivation that is integral to the learning environment, or extrinsic, coming from outside the learning environment?
10. **Structure**. Structure can vary from tightly prescribed pathways to widely divergent options. Although low levels of structure may seem to promote increased individualization, learners may become confused and lose track of what they are doing.
11. **Accommodation of Individual Differences**. How does the package accommodate differences in aptitude, prerequisite knowledge, motivation, experience, learning style? What cognitive scaffolding is provided to support learning? e.g. advanced organizers, outlines, content maps, time estimates.
12. **Cooperative Learning**. How does the package facilitate instructional methods in which learners work together to accomplish shared goals.

The Evaluation Study

This exploratory study was conducted at Marist Sisters' College, Woolwich, Sydney in early 1995. The college is a Catholic, systemic, secondary girls school with 700 students enrolled from Year 7 to 12. The college's information infrastructure combines the traditional, predominantly paper-based library resources and networked information technology. The technological component consists of an electronic library catalogue, a curriculum applications server and 14 CD-ROM drives networked to 57 workstations throughout the college. The information technology provides users with access to the College's library catalogue, to desktop publishing, teaching/learning packages, internet and multimedia from workstands situated in a computer laboratory, classrooms, staffroom, library and information laboratory adjacent to the library

facility. "Encarta" the Microsoft multimedia package was evaluated in the study.

"Encarta 94" as described by Microsoft starts with the complete text of the 29-volume Funk and Wagnal's New Encyclopedia plus many new articles, photos, animations, detailed illustrations, music segments, and sounds. According to the publisher, this package "harnesses all the power of the personal computer to inspire curiosity, open the door to wonder, and take your family on a learning journey that never ends. It makes learning engaging and easy by putting a world of knowledge right at our fingertips". In this study students were asked to evaluate their experience of the package without any of the publisher's type.

Seventy students were involved in this evaluation study. Students were selected randomly over one week as they worked on the multimedia workstations around the school. Students were initially asked if they has used "Enact" and only those students with previous experience (that is, they had used "Encarta" before to access information) were included in the study. A profile of these students is provided in Table 1.

Class Level	Number	Percent
Year 7	17	24
Year 8	01	01
Year 9	28	40
Year 11	06	09
Year 12	18	26

Table 1

Seventeen percent of the students, primarily in Year 7, indicated that they were novice users, having used "Encarta" only a few times previously. 77% of the sample described themselves as average users, that is, they were quite comfortable with using the package and had used it at least on several occasions previously. They were drawn mainly from Years 9, 11 and 12. 6% of the sample described themselves as expert users, primarily from years 11 and 12, who had used the package on many occasions, and felt very comfortable with searching through it.

Data Collection

A questionnaire was developed to indicate the evaluative reactions to "Encarta" in terms of: Ease of Use, Navigation, Cognitive Load, Mapping, Screen Design, Knowledge Space Complexity, Information Presentation, Media Integration, and Overall Functionality. These were elaborated from the user-centered dimensions of Reeves (1992) and Reeves and Harmon (1993). For each of these categories, a number of statements were developed, and students were asked to respond to each statement in terms of an agreement rating using a five point Likert scale from 5=strongly agree to 1=strongly disagree. To establish how important each dimension was in the evaluation process, students were also asked to respond to each statement using an importance rating with a four point Likert scale from 4=very important to 1=not important at all. A range of statements for each of the categories was developed, for example, for Navigation: *"I get lost when searching "Encarta"; I always know where I am in Encarta"*. In addition, some free generation questions were included that sought to clarify and elaborate on the responses students made. These questions were:

What I like most about Encarta is...
What I like least about Encarta is...
The problems I have when using Encarta are...
What are the advantages of using electronic information resources rather than paper resources?
What are the disadvantages of using electronic information resources rather than paper resources?

Table 2 shows the overall reaction to Encarta, based on composite means for each individual statement.

OVERALL AGREEMENT RATING RANK ORDER 5=Strongly Agree 1= Strongly Disagree	
Dimension	**Mearn Score**
Information presentation	4.14
Knowledge space complexity	4.08
Screen design	3.98
Media integration	3.89
Overall functionality	3.81
Ease of use	3.68
Mapping	3.66
Cognitive load	3.49
Navigation	3.23

Table 2

At a general level, *Encarta* fares positively in terms of each dimension examined. Table 3 identifies the specific features of Encarta that were ranked the highest, and lowest.

SPECIFIC DIMENTSIONS: HIGHEST AND LOWEST AGREEMENT RATING 5= Strongly Agree 1=Strongly Disagree	
Features of *Encarta* students ranked highest	
Dimension	**Mean Score**
Information is presented in ways easy to understand	4.17
Photos and drawings are of good quality	4.14
I'm comfortable with using *Encarta*	4.13
I'm able to put information to good use	4.11
I am able to move through the contents successfully	4.10
Information is organized in a clear logical way	4.09
Information in *Encarta* isn't to difficult to use	4.09
Features of *Encarta* students ranked lowest	
Able to keep track of all the choices made while searching	3.54
I am able to backtrack easily	3.51
I always know where I am when searching *Encarta*	3.63
I understand the way all the information is organized	3.70
Encarta generally meets my information needs	3.74

Table 3

A different picture emertes when one explores the imortance given to each of the categories used for evaluation, as shown in tabesl 4 and 5.

OVERALL IMPORTANCE RATING: RANK ORDER 4=Very Important 1=Not Important at All	
Dimension	**MEAN SCORE**
Knowledge space complexity	3.42
Ease of use	3.34
Information presentation	3.26
Mapping	3.24
Media presentation	3.20
Overall functionality	3.19
Cognitive load	3.11
Navigation	3.03
Screen design	2.97

Table 4

COMPARATIVE RANKINGS: AGREEMENT VS IMPORTANCE		
DIMENSION	**MEAN IMPORTANCE**	**MEAN AGREEMENT**
Knowledge space complexity	1	2
Ease of use	2	6
Information presentations	3	1
Mapping	4	7
Media integration	5	4
Overall functionality	6	5
Cognitive load	7	8
Navigation	8	9
Screen design	9	3

Table 5

When searching a multimedia resource, students appear to value most the knowledge space complexity dimension, that is, the capacity of the package to help them make sense of new information in relation to what they already know; to enable them to build on what is known in order to complete the learning tasks required of them. The descriptive comments indicate

students' recognition of information as an essential component of their learning, not existing in isolation but rather to be integrated into their personal knowledge base. As shown in Table 5, students concur that Encarta fulfills their expectations with regard to the knowledge space complexity dimension. They agree with the publisher that they can learn from such a package. While students recognize ease of use as an important dimension (Rank 2) it was given a relatively lower ranking (Rank 6) in terms of agreement.

Students indicate they want more from Encarta in terms of the mapping dimension. Strongly expressed in their comments was the need to keep track of where they are at, being able to backtrack, or move in divergent paths and to see clearly the character of their multidirectional searching. As these functions are available in the package it begs the question, are they obvious or easily accessed by users. The package does allow for divergent search paths based on Categories. Outline and See indexes and continuously records each user's path through the electronic maze such that backward and forward re-searches are possible. The fact that all levels of students appear to be unaware of these functions may indicate that the screen display is either too crowded with options or that the function labels are not self-explanatory.

Some beginners identified a range of attributes that primarily centered around quick and easy access to information, that is where the major points of information about a topic may take much longer to find in print resources, they are grouped together and easier to access in the package. In addition, they liked the pictures and film clips, with some indication that they helped them understand the topics.

Average and expert users also identified the above strengths. Specific reference was made to language being easy to understand; information was up to date; instructions were easy to follow; the integration of the different media, particularly those with action, made it easier to understand the information, and to imagine processes and ideas.

Obviously not all students were satisfied with various aspects of the package. 46% of students, at all year and experience levels represented commented on the limited quantity of information. They were dissatisfied with the range of topics available and the depth of coverage within a specific topic. While some saw it as a one- stop shop for all information requirements, there was also some recognition of the need to use additional sources as well to complete research tasks. 12% of the students expressed difficulty managing the search process utilized by the package and these difficulties included keeping track of position, understanding how to retrace steps or move on and defining search terms with managing the search process. As examples students referred to "information not being in a category you think it is". "I can't find the information I want but it's there under a different name"; and understanding how to retrace steps or to move on.

Students saw a range of advantages and disadvantages in the use of electronic media versus print. 65% of the students said the information search was easier, more efficient and quicker to access, and that the information was always available with no problems incurred by someone else having borrowed the sources. 11% of students indicated that the task was more fun, more interesting to read and learn, more exciting and more enjoyable than when using print resources. ,"It doesn't seem like you are doing something for school" was a typical response. Several students highlighted the place of information technology in society, for example: "Computers are what life's all about now" and "It's our future, our jobs will use it". Average and expert users also identified these strengths. Specifically that the language was easy to understand; information was perceived as being current; instructions were easy to follow; and that the integration of the different media, particularly those with action, made it easier to understand the ideas and information. These types of claims are often made by producers and, at least in this case, they were upheld by the user evaluations.

Encouraging also was the students recognition that there are disadvantages. The major disadvantage cited by students related to the lack of depth and complexity of information in the package, and this was linked to the perception that books provide greater detail and depth comparatively speaking. Many students expected more of the electronic resource, appearing to realize the capacity of the format to provide more, and they were disappointed. The confusion over topic descriptors and the lack of depth in some topics stems from the fact that Encarta projects the cultural and historical bias of the manufacturer, with very little material relevant to Australian history or current affairs. This is significant for students of a curriculum with emphasis on

national as well as international issues. The Northern American bias of the product has been commented on by the users in terms of its lack of information on current topics whose focus is not American.

One student identified the product's potential for encouraging plagiarism in the following ways: "if you want the information you could print it out and just hand it in as your assignment"; another indicated "you tend to grab too much information and not use your own brains". These comments typify concerns expressed by both teachers and students and emphasize the need to construct tasks which require more than the simple reiteration of facts.

Another major disadvantage, though not related to Encarta per se, was the problem of access being affected by system downtimes. A lightning strike had caused severe damage to the entire network earlier in the academic year and system reconstruction took many weeks. At the time of the study the students had been without access for almost a term and therefore were very aware of the down side of information technology dependence. One student expressed this quite succinctly: "It's less reliable than paper, especially with system downs". Beginning users also identified a problem information loss; that is material either failing to print or working documents being deleted. These are usually rare occurrences that due to system restructuring had been happening quite frequently during the days preceding the study.

It is of interest to note that some of the features of Encarta found by this study to be "unfriendly" or difficult to apply have been modified or removed from the 1995 edition of the product. For example the point at which you identify on what medium you wish to search has been moved forward in the structure and the procedure for copying text or image to disk or document has been simplified by the removal of three steps of the process. The Outline and See cross indexes have been altered to become a single button option titled Related Articles, which is plain language for the function. Other features of the 1995 version require learners to re-learn where common functions can be found and new functions have been added that are, again, difficult to decipher. A very popular feature of the earlier editions was a search path that presented the image of a shelf of encyclopedias where users merely indicated the letter of the alphabet in which they were interested. This has been removed from the new edition. Being so similar to users' paper based encyclopedic search methods, it was their preferred method with the electronics medium and its absence has caused quite a stir among many of the students. It is clear that multimedia producers need greater input from their prospective audiences to determine whether programming and glossy improvements produce, in practice, a better information product.

The evaluation highlights the essential role of information literacy education for information seekers in electronic information environments. It is the clearest message of the findings. Students' difficulties in understanding directions, commands and terminology, generating search terms and dealing with the mismatch of perceptions of how information is organized and how it actually is organized, understanding how to move in multiple directions in the package, understanding how the information is structured and how this shapes the design of the search, locating related and specific information through broadening and narrowing of searches, dealing with the problems of little or no useful information are all issues that can be resolved through effective information literacy education. Possible strategies (based on Neuman 1993) might include: individualized, hands-on instruction in searching; collaborative teacher-librarian and student searching; peer tutoring where expert students work with novices; more teacher and teacher-librarian collaboration on planning and conducting instruction that involves extensive electronic searching, and collaboration helping students judge the usefulness of electronic information retrieved. Also important is ensuring that research tasks are designed in such a way to develop information and reasoning skills such as comparison, contrast, analysis, synthesis, and metacognitive abilities such as assessment, discrimination, classification, and judgement of information. Without these skills students will capitalize on multimedia's ease of use to indulge their plagiaristic habits.

At a broader level, teacher-librarians need to recognize and ensure that one of the goals of incorporating electronic information sources into the curriculum is to help students master the higher order thinking skills involved in designing, conducting and interpreting research. Since teacher-librarians have an important role to play in the school in familiarizing students and teachers with electronics databases, their use and possibilities, they should be proficient in their required skills.

Teacher-librarians need to give careful thought to the selection of appropriate multimedia and to actively contribute to the multimedia debate. It is important that informed judgements are made about the appropriateness and limitations of multimedia and that we share this with the professional community; that we build an understanding of multimedia's role in meeting information needs, how it shapes information seeking behavior, and how it is being used, and what are the most appropriate support mechanisms for fostering effective use of multimedia packages in our agencies.

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